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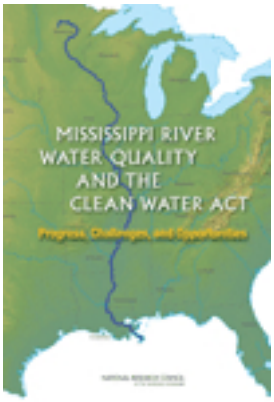

Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities

Committee on the Mississippi River and the Clean Water Act, National Research Council

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The Mississippi River is, in many ways, the nation's best known and most important river system. Mississippi River water quality is of paramount importance for sustaining the many uses of the river including drinking water, recreational and commercial activities, and support for the river's ecosystems and the environmental goods and services they provide. The Clean Water Act, passed by Congress in 1972, is the cornerstone of surface water quality protection in the United States, employing regulatory and nonregulatory measures designed to reduce direct pollutant discharges into waterways. The Clean Water Act has reduced much pollution in the Mississippi River from "point sources" such as industries and water treatment plants, but problems stemming from urban runoff, agriculture, and other "non-point sources" have proven more difficult to address. This report concludes that too little coordination among the 10 states along the river has left the Mississippi River an "orphan" from a water quality monitoring and assessment perspective. Stronger leadership from the U.S. Environmental Protection Agency (EPA) is needed to address these problems. Specifically, the EPA should establish a water quality data-sharing system for the length of the river, and work with the states to establish and achieve water quality standards. The Mississippi River corridor states also should be more proactive and cooperative in their water quality programs. For this effort, the EPA and the Mississippi River states should draw upon the lengthy experience of federal-interstate cooperation in managing water quality in the Chesapeake Bay.

Summary

Flowing approximately 2,300 miles from Lake Itasca to the Gulf of Mexico, the Mississippi River represents a resource of tremendous economic, environmental, and historical value to the nation. The Mississippi River drains the vast area between the Appalachian and the Rocky Mountains, making it the world's third-largest river basin, behind the Amazon and the Congo River basins. The river supports numerous economic and recreational activities including boating, commercial and recreational fishing, tourism, hiking, and hunting. Mississippi River water quality is of paramount importance for the sustainability of the many uses of the river and the ecosystems dependent on it. Numerous cities and millions of inhabitants along the river use the Mississippi as a source of drinking water. Water quality is also important for many recreational and commercial activities. The river's ecosystems and its avian and fish species rely on good water quality for their existence. These ecosystems and the species they support are highly valued and are especially important to communities and economies along the river and along the Louisiana Gulf Coast.

There are many differences between the upstream and downstream portions of the mainstem Mississippi River. Much of the upper Mississippi River is a river-floodplain ecosystem that contains pools, braided channels, islands, extensive bottomland forests, floodplain marshes, and occasional sand prairie. The upper river is home to the Upper Mississippi River National Wildlife and Fish Refuge, which covers 240,000 acres and extends 261 miles along the river valley from Wabasha, Minnesota, to Rock Island, Illinois. Further downstream, many large flood protection levees line the lower river and have severed natural connections between the river chan-

nel and its floodplain. There are fewer backwater areas and islands than along the upper river and fewer opportunities for river-related recreation. Moreover, the lower Mississippi River's larger flows and dangerous currents and eddies inhibit river-based recreation and impede water quality monitoring. These upstream-downstream differences affect the nature of water quality problems and the extent of water quality monitoring along the length of the river.

Mississippi River water quality is affected by land use practices, urbanization, and industrial activities across its large drainage basin. Many of these activities, including those that take place hundreds of miles away from the main river channel (or mainstem), can degrade Mississippi River water quality. The establishment of cities and commercial activities along the river has contributed to degraded water quality through increasing pollutant discharges from cities and industry. Congress first enacted the Federal Water Pollution Control Act (FWPCA) in 1948. Congress amended the FWPCA repeatedly from 1956 on; however, substantial amendments in 1972 created the contemporary structure of the act, which acquired the name Clean Water Act in 1977 amendments. An overarching objective of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

The Clean Water Act has achieved successes in reducing point source pollution, or pollution discharged from a discrete conveyance or pipe (e.g., industrial discharge or a wastewater treatment plant), but nonpoint pollution, which originates from diffuse sources such as urban areas and agricultural fields, has proven more difficult to manage. Despite improvements since passage of the Clean Water Act, the Mississippi River today experiences a variety of water quality problems. Many of these problems emanate from nonpoint pollutant sources. Although the Clean Water Act can be used to address nonpoint source pollution problems, its provisions for doing so have less regulatory authority than its provisions for addressing point source pollution.

This report focuses on water quality problems in the Mississippi River and the ability of the Clean Water Act to address them. Data needs and system monitoring, water quality indicators and standards, and policies and implementation are addressed (the full statement of task to this committee is contained in Chapter 1). The geographic focus of this report is the 10-state mainstem Mississippi River corridor and areas of the Gulf of Mexico affected by Mississippi River discharge. Water quality in the Mississippi River and the northern Gulf of Mexico, however, is affected by activities from across the entire river basin. Comprehensive Mississippi River water quality management programs therefore must consider the sources of pollutant discharges in all tributary streams, as well as along the river's mainstem. This report therefore also discusses landforms, land use changes, and

land and water management practices across the Mississippi River basin that affect mainstem water quality.

The committee was not specifically charged to consider possible statutory changes to the Clean Water Act. The committee discussed this topic and chose to conduct its investigations and present its findings and recommendations entirely within the framework of the existing Clean Water Act.

FINDINGS

Mississippi River Water Quality Problems

Numerous human activities across the Mississippi River basin affect the water quality of the mainstem Mississippi River and the northern Gulf of Mexico. These activities include discharges from industries, urbanization, timber harvesting, construction projects, agriculture, and landscaping practices. Along the mainstem Mississippi, major hydrologic modifications implemented over the past 150 years also affect water quality. These modifications include river channelization, locks and dams (and associated navigation pools) of the upper Mississippi River navigation system, many large levees along the lower river, and losses of large areas of natural wetlands.

These activities and modifications contribute to many water quality problems along the river's mainstem that vary and are of different magnitude in different parts of the river. These problems can be divided into three broad categories: (1) contaminants with increasing inputs along the river that accumulate and increase in concentration downriver from their sources (e.g., nutrients and some fertilizers and pesticides); (2) legacy contaminants stored in the riverine system, including contaminants adsorbed onto sediment and stored in fish tissue (e.g., polychlorinated biphenyls [PCBs]; dichlorodiphenyltrichloroethane [DDT]); and (3) "intermittent" water constituents that may or may not be considered contaminants, depending on where they are found in the system, at what levels they exist, and whether they are transporting adsorbed materials that are contaminants. The most prominent component in the latter category is sediment. In some portions of the river system, sediment is overly abundant and can be considered a contaminant. In other places it is considered a natural resource in deficient supply.

Differences in inputs of pollutants in different parts of the river basin contribute to varying water quality problems along the length of the river. For example, downstream sediment loads are greatly affected by sediment inputs from, and retention in, the river's many tributary streams. Nutrients enter the Mississippi River at many points along its course, primarily from nonpoint sources in agricultural areas in the upper Mississippi River basin that are not subject to Clean Water Act permit programs. Nitrogen and

phosphorus are nutrients of special concern. These nutrients ultimately are discharged into the Gulf of Mexico, where nitrogen causes large-scale problems in the form of hypoxia and other coastal ecosystem disturbances, including impairment of Gulf fish populations. In other portions of the river system, primarily in the upper river, excessive loadings of phosphorus constitute a problem (e.g., in Lake Pepin in southern Minnesota).

Sediment problems are more complex. For example, in the upper Mississippi River, high rates of sediment input and deposition are key concerns. Sediment loads in the upper river today are greater than they were in the mid- to late eighteenth century, when the basin was being settled by European immigrants. The system of locks and dams and navigation pools put in place on the upper river in the early twentieth century affects sediment transport and deposition significantly. In the lower Mississippi River below Alton, Illinois, deprivation of sediments—due in large part to the trapping of large amounts of sediment behind a series of dams and reservoirs on the Missouri River—is a problem. Sediment deprivation is, for example, a key contributor to losses of coastal wetland systems in southern Louisiana. This problem is enhanced to some degree by extensive levee structures along the lower part of the river that do not allow sediments to spread into and across floodplains and wetlands adjacent to the river and its tributaries.

Identifying the most important water quality problems in the mainstem Mississippi River depends on the scale examined. At the local level, for instance, problems with toxic substances and bacteria may be of primary concern to citizens and regulators. **However, at the scale of the entire Mississippi River, including its effects that extend into the northern Gulf of Mexico, nutrients and sediment are the two primary water quality problems. Nutrients are causing significant water quality problems within the Mississippi River itself and in the northern Gulf of Mexico. With regard to sediment, many areas of the upper Mississippi River main channel and its backwaters are experiencing excess suspended sediment loads and deposition, while limited sediment replenishment is a crucial problem along the lower Mississippi River and into the northern Gulf of Mexico.**

Water Quality Monitoring and Assessment

The Mississippi River serves as a border between states along much of its course from Lake Itasca to the Gulf of Mexico. Some states along the river view Mississippi River water quality as primarily a federal responsibility—especially states in the lower stretch of the river. Many of the 10 states along the river thus allocate only small amounts of funds for water quality monitoring and related activities. Moreover, there is very limited coordination among the Mississippi River states on water quality monitoring activities. The Clean Water Act is relatively clear in delineating

responsibilities for state-specific water quality monitoring and assessment; it is less clear in addressing issues of coordinated interstate river monitoring and assessment to ensure that water quality data are collected and analyzed in a consistent fashion. **As a result of limited interstate coordination, the Mississippi River is an "orphan" from a water quality monitoring and assessment perspective.**

The orphan-like nature of the Mississippi River entails several unique water quality monitoring and management challenges. One problem stems from the fact that individual states generally are responsible for monitoring the stretch of the Mississippi River that flows through or abuts them. The Mississippi River flows within only two states—Minnesota and Louisiana—of the ten states along its corridor. For the other eight states, the river forms a boundary between them. Although there are some important federally sponsored efforts in monitoring Mississippi River water quality—such as those conducted by the U.S. Army Corps of Engineers and the U.S. Geological Survey, especially on the upper river—there is no single water quality monitoring program or central water quality database for the entire length of the Mississippi. Thus, there are limited amounts of water quality and related biological and ecological data for the full length of the Mississippi River, especially the lower river. This limited amount of data inhibits evaluations of water quality problems along the river and into the Gulf of Mexico, which in turn inhibits efforts to develop, assess, and adjust water quality restoration activities. Moreover, the limited attention devoted to monitoring the river's water quality is not commensurate with the Mississippi River's exceptional socioeconomic, cultural, ecological, and historical value. **The lack of a centralized Mississippi River water quality information system and data gathering program hinders effective implementation of the Clean Water Act and acts as a barrier to maintaining and improving water quality along the Mississippi River and into the northern Gulf of Mexico.**

Effectiveness of the Clean Water Act

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. It employs a variety of regulatory and nonregulatory tools designed to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, protect wetlands, and manage polluted runoff. Congress designed the 1972 act "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The act also called for zero discharges of pollutants into navigable waters by 1985 and "fishable and swimmable" waters by mid-1983. The U.S. Environmental Protection Agency (EPA) and the states are primarily and jointly responsible for implementing the act. The U.S. Army Corps of Engineers also plays a role in Clean Water Act implementation,

because it shares responsibility with the EPA in the act's Section 404 wetlands permitting program.

The Clean Water Act aims to achieve water quality improvements by requiring categorical technology-based standards for point source dischargers. The Clean Water Act has been effective in addressing many point source pollution problems, such as discharges from industrial sources and publicly owned sewer systems and treatment works. Further improvements in control of point sources of pollution—notably in connection with urban stormwater and combined sewer overflows—are possible. Such changes, however, are likely to have limited effects on mainstem and northern Gulf of Mexico water quality because only approximately 10 percent of Mississippi River nitrogen loading is from point sources.

For waterbodies that remain impaired after the application of technology-based and water quality-based controls of point source discharges, the Clean Water Act requires application of water quality standards and Total Maximum Daily Loads (TMDLs). The TMDL represents both a planning process to implement standards and a numerical quantity for a pollutant load to receiving waters that will not result in violation of state water quality standards within an adequate margin of safety. The Clean Water Act requires states or the Environmental Protection Agency to develop TMDLs for waterbodies that do not meet water quality standards. **The Clean Water Act has been effective in addressing point sources of water pollutants. Notably, however, the Clean Water Act addresses nonpoint source pollution only in a limited, indirect manner. This is a crucial difference given the significance of nonpoint source water pollution throughout the nation and its special importance to Mississippi River and northern Gulf of Mexico water quality.**

The Total Maximum Daily Load framework is a key aspect of the Clean Water Act and is designed, in part, to address nonpoint source pollutants and to protect and restore water quality. The TMDL concept and its implementation have been used to address both point and nonpoint source inputs to many waterbodies in the United States. The TMDL framework is more easily implemented in smaller watersheds within individual states. Larger rivers and rivers with watersheds that encompass multiple states pose significant implementation challenges for the TMDL framework, particularly with respect to nonpoint source pollution. **For TMDLs and water quality standards to be employed effectively to manage water quality in interstate rivers such as the Mississippi, it is essential that the effects of interstate pollutant loadings be considered fully in developing the TMDL.**

A lack of coordination among federal- and state-level efforts, limited federal oversight of CWA implementation, and failure of some states to include the Mississippi River within their state water quality monitoring programs all contribute to the inability of the EPA and the states to ad-

dress adequately water quality degradation in the Mississippi River and into the northern Gulf of Mexico. The Clean Water Act requires the EPA to establish water quality criteria; oversee and approve state water quality standards and TMDLs; take over the setting of water quality standards and the TMDL process when state efforts are inadequate; and safeguard water quality interests of downstream and cross-stream states. **The Clean Water Act assigns most interstate water quality coordination authority to the EPA. The Clean Water Act also encourages the EPA to stimulate and support interstate cooperation to address larger-scale water quality problems. The act provides the EPA with multiple authorities that would allow it to assume a stronger leadership role in addressing Mississippi River and northern Gulf of Mexico water quality.**

Despite the authority granted to the EPA in the Clean Water Act, one of the nation's key, large-scale water quality problems—the hypoxic zone in the northern Gulf of Mexico—continues to persist. The Gulf hypoxic zone is a large area that clearly is not meeting the CWA goal of fishable and swimmable waters. **The EPA has failed to use its mandatory and discretionary authorities under the Clean Water Act to provide adequate interstate coordination and oversight of state water quality activities along the Mississippi River that could help promote and ensure progress toward the act's fishable and swimmable and related goals.**

Programs and policies designed to achieve improvements in water quality for the Mississippi River and the northern Gulf of Mexico are affected by the following factors:

1. Resolution of many Mississippi River water quality issues is constrained by pre-CWA structural alterations to the river—for example, locks, dams, and levees, and the losses of wetlands—that the Clean Water Act cannot undo;
2. The Clean Water Act contains no authorities that directly regulate nonpoint sources of pollutants;
3. The Clean Water Act specifically exempts agricultural stormwater discharges and return flows from irrigated agriculture from being regulated as point source discharges and does not address agricultural nonpoint source pollution except as it leaves all nonpoint source pollution management to the states;
4. The interstate nature of the Mississippi River poses complications in coordinating water quality standards and monitoring programs among ten states and four EPA regions;
5. Large rivers such as the Mississippi are physically difficult to monitor, evaluate, and characterize; and
6. Pollutant loadings from ten states impact the Mississippi River and extend into the northern Gulf of Mexico.

Many structural and physical changes to the Mississippi River predate passage of the Clean Water Act. Moreover, Congress did not design the Clean Water Act to address every process that affects Mississippi River water quality. The Clean Water Act has been effective in reducing many pollutant discharges from point sources, but other processes such as levee construction, urbanization, and forestry activities affect Mississippi River quality and are not subject to the regulatory provisions of the Clean Water Act. **The Clean Water Act cannot be used as the sole legal vehicle to achieve all water quality objectives along the Mississippi River and into the northern Gulf of Mexico. Nevertheless, the Clean Water Act provides a legal framework that, if comprehensively implemented and rigorously enforced, can effectively address many aspects of intrastate and interstate water pollution, although the emphasis to date has been predominantly on the former.**

Nonpoint Source Pollution and Agriculture

Since agriculture contributes the major portion of nutrients and sediments delivered to the Mississippi River, reductions in pollutant loadings, especially nutrients, from the agricultural sector are crucial to improving Mississippi River water quality. Not all agricultural producers across the river basin contribute equal amounts of nutrients and sediments in runoff. Water quality protection programs thus need not be implemented in every watershed and on every farm to realize substantial water quality improvements further downstream. The careful targeting of programs to areas of higher pollutant loadings could enhance the effectiveness of conservation programs designed to reduce nutrient and sediment runoff.

The U.S. Department of Agriculture (USDA) administers a number of incentive-based programs designed to implement best management practices (BMPs) and/or reduce levels of nutrient and sediment inputs and runoff. USDA programs to reduce environmental impacts of agriculture include the Conservation Reserve Program (CRP), the Environmental Quality Incentive Program (EQIP), and the Conservation Security Program (CSP). These programs aim to balance incentives for crop production with incentives for land and water conservation. Participation is voluntary, but there are financial incentives for implementing BMPs.

A key issue in Midwest agriculture today is the potential increase in crop land and production dedicated to biofuels. Recent interest in biofuels production is encouraging producers to extend and intensify crop production in much of the upper Mississippi River basin. Much of this expanded production is in corn, which entails large applications of nutrient fertilizers. As a result, sediment and nutrient runoff from agricultural land in the upper basin is likely to increase. Although increases in grain production for

biofuels, particularly on marginal agricultural lands that contribute high nutrient loads, may have substantial consequences for Mississippi River and northern Gulf of Mexico water quality, these potential impacts have not been fully evaluated.

RECOMMENDATIONS

Agriculture and Mississippi River Water Quality

Effective management of nutrient and sediment inputs and other water quality impacts from agricultural sources will require site-specific, targeted approaches involving best management practices. Existing USDA programs provide vehicles for implementing nonpoint source controls in agriculture, but they will require closer coordination with the EPA and state water quality agencies to realize their full potential for improving water quality. The EPA could assist the USDA to help improve the targeting of funds expended in the CRP, EQIP, and CSP. The national financial investment and scope of these USDA programs is large. A focus on these programs is important because the Clean Water Act does not authorize regulation of nonpoint sources of pollutants such as agricultural lands. Recent developments in the prospects for increased biofuels production, and the increased nutrient and sediment pollutant loads this would entail, provide an even stronger rationale to expedite targeted applications of USDA conservation programs and enhanced EPA-USDA coordination.

Targeting USDA conservation programs to areas of higher nutrient and sediment loadings can lead to BMPs for control of runoff containing sediment and nutrients being implemented on lands that are the primary sources of nonpoint pollutants. This provides an opportunity to strengthen EPA-USDA interagency collaboration: the EPA, for example, can assist USDA in identifying lands that should receive priority and can cooperate with USDA and producers in monitoring changes in water quality and making subsequent adjustments and improvements in nutrient management programs. The U.S. Geological Survey (USGS) also could play an important role in this collaboration by sharing its considerable expertise and data related to water quality monitoring.

It is imperative that these USDA conservation programs be aggressively targeted to help achieve water quality improvements in the Mississippi River and its tributaries. Programs aimed at reducing nutrient and sediment inputs should include efforts at targeting areas of higher nutrient and sediment deliveries to surface water. The EPA and the USDA should strengthen their cooperative activities designed to reduce impacts from agriculture on the water quality of the Mississippi River and the northern Gulf of Mexico.

State-Level Leadership

The 10 mainstem Mississippi River states have different priorities regarding the river and devote different levels of resources to water quality data collection. Broadly speaking, there is a distinction between priorities and approaches of the upper river states compared to the lower river states. One example of these differences is that the upper river states participate in a governor-supported interstate body—the Upper Mississippi River Basin Association (UMRBA). The five upper river state governors established the UMRBA in 1981 to help coordinate river-related programs and policies and to work with federal agencies with river responsibilities. The UMRBA has sponsored discussions and studies on many water quality issues. At a strategic level, the UMRBA represents an interstate commitment to cooperation on river management issues. There is no equivalent organization for the lower river states. The Lower Mississippi River Conservation Committee (LMRCC) is a multistate organization established to discuss issues of river biology and restoration, but it does not have gubernatorial appointees or employ full-time staff like the UMRBA.

Effective water quality protection and restoration requires that the Mississippi River be managed as an integrated system. Working together, the 10 Mississippi River states will achieve far more, with greater efficiencies, than each state working alone. Mississippi River states will have to be more proactive and cooperative in their water quality programs for the Mississippi River if marked improvements in water quality are to be realized. A mechanism for the lower river states to promote this coordination could take different forms, such as a forum for information exchange or an organization with a more formal status. **Better interstate cooperation on lower Mississippi River water quality issues is necessary to achieve water quality improvements. The lower Mississippi River states should strive to create a cooperative mechanism, similar in organization to the UMRBA, in order to promote better interstate collaboration on lower Mississippi River water quality issues.**

EPA Leadership

Several federal agencies maintain programs related to water quality monitoring across the Mississippi River watershed and into the northern Gulf of Mexico. For example, the National Oceanic and Atmospheric Administration (NOAA) collects water quality data for the Gulf of Mexico, the U.S. Army Corps of Engineers oversees the federal-state Environmental Management Program for the upper Mississippi River, and the USGS has collected water quality data for many years at select Mississippi River stations under different monitoring programs. All of these programs have

merit, but there is no single federal program for water quality monitoring and data collection for the river as a whole. The past and current approach to water quality management in the Mississippi River is fragmented, with different agencies conducting their own monitoring programs and having different goals. This does not lend itself to a coherent program designed to monitor and consider the Mississippi River as a whole. The Mississippi River, with its extensive interstate commerce, its ecosystems that cross state boundaries, and its effects that extend into the northern Gulf of Mexico, clearly is a river of federal interest. There are compelling reasons for the federal government to promote the monitoring and evaluation of this river system as a single entity.

Better coordination and a greater degree of centralization of water quality monitoring and data collection along the Mississippi River are essential to ensure that similar parameters are being measured consistently along the entire length of the river; that similar methods, units, and timing of measurements are being used along the entire river; and that the placement and operations of monitoring stations are coordinated. There is an adequate scientific basis to undertake an expanded monitoring program for the Mississippi River. Better coordination is fundamental to streamlining federal expenditures and efforts for water quality monitoring along the river and, ultimately, to achieving water quality improvements in the Mississippi River and the northern Gulf of Mexico. This will help ensure an integrated program that enables consistent, science-based decisions about important water quality monitoring issues.

There is a clear need for federal leadership in system-wide monitoring of the Mississippi River. The EPA should take the lead in establishing a water quality data sharing system for the length of the Mississippi River. The EPA should place priority on coordinating with the Mississippi River states to ensure the collection of data necessary to develop water quality standards for nutrients in the Mississippi River and the northern Gulf of Mexico. The EPA should draw on the considerable expertise and data held by the U.S. Army Corps of Engineers, the USGS, and NOAA.

The EPA should act aggressively to ensure improved cooperation regarding water quality standards, nonpoint source management and control, and related programs under the Clean Water Act. This more aggressive role for EPA is crucial to maintaining and improving Mississippi River and northern Gulf of Mexico water quality and should occur at several levels. **The EPA administrator should ensure coordination among the four EPA regions along the Mississippi River corridor so that the regional offices act consistently with regard to water quality issues along the Mississippi River and in the northern Gulf of Mexico.**

Regarding cooperation and communication among the Mississippi River states, **the EPA should encourage and support the efforts of all 10**

Mississippi River states to effect regional coordination on water quality monitoring and planning and should facilitate stronger integration of state-level programs. The EPA has an opportunity to broker better interstate collaboration and thereby improve delivery of Clean Water Act-related programs, such as permitting, monitoring and assessment, and water quality standards development. The EPA should provide a commensurate level of resources to help realize this better coordination. One option for encouraging better upstream-downstream coordination would be through a periodic forum for state and regional water quality professionals and others to identify and act upon appropriate Clean Water Act-related concerns.

There are currently neither federal nor state water quality standards for nutrients for most of the Mississippi River, although standards for nutrients are under development in several states. Numerical federal water quality criteria and state water quality standards for nutrients are essential precursors to reducing nutrient inputs to the river and achieving water quality objectives along the Mississippi River and in the northern Gulf of Mexico. A TMDL could be set for the Mississippi River and the northern Gulf of Mexico. This would entail the adoption by EPA of a numerical nutrient goal (criteria) for the terminus of the Mississippi River and the northern Gulf of Mexico. An amount of aggregate nutrient reduction—across the entire watershed—necessary to achieve that goal then could be calculated. Each state in the Mississippi River watershed then could be assigned its equitable share of reduction. The assigned maximum load for each state then could be translated into numerical water quality criteria applicable to each state's waters.

Regarding cooperation with the Mississippi River states on water quality standards and criteria, **the EPA should develop water quality criteria for nutrients in the Mississippi River and the northern Gulf of Mexico. Further, the EPA should ensure that states establish water quality standards (designated uses and water quality criteria) and TMDLs such that they protect water quality in the Mississippi River and the northern Gulf of Mexico from excessive nutrient pollution. In addition, through a process similar to that applied to the Chesapeake Bay, the EPA should develop a federal TMDL, or its functional equivalent, for the Mississippi River and the northern Gulf of Mexico.**

The actions recommended in this report will not be easy to implement. They will entail a greater degree of collaboration and compromise among interest groups, states, and agencies than in the past. They are, however, necessary if the goals of the Clean Water Act are to be realized and the Mississippi River provided a level of protection and restoration commensurate with its integral commercial, recreational, ecological, and other values.

MISSISSIPPI RIVER WATER QUALITY AND THE CLEAN WATER ACT

Progress, Challenges, and Opportunities

Committee on the Mississippi River and the Clean Water Act

Water Science and Technology Board

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Preface

The Mississippi River has long been one of the great defining natural features of the United States. "Mississippi" is an Ojibwa (Chippewa) Indian word meaning "great river" or "gathering of waters." The first recorded European to see the Mississippi River was Hernando de Soto, who led a Spanish expedition across the river in 1541. In their search for a Northwest Passage, Marquette and Joliet traveled on the river in 1673. Shortly after the Louisiana Purchase, while Lewis and Clark were leading the Corps of Discovery up the Missouri River and to the Pacific Ocean, U.S. Army Lieutenant Zebulon Pike was leading a military reconnaissance expedition up the Mississippi River in the summer of 1805. Later, during the steamboat era of the 1800s, Samuel Clemens traveled the river and began writing his impressions of steamboating and river life under the pen name of Mark Twain.

In addition to the rich history and culture surrounding the Mississippi River, the length of the river and the extent of its basin are exceptional and part of the river's uniqueness. It is one of the world's largest rivers in terms of both length and basin size. The basin encompasses almost half the area of the continental United States and contains many different ecosystems, climate zones, and land uses. Several of the Mississippi's tributaries, such as the Arkansas, Missouri, Ohio, White, and Wisconsin Rivers, are large rivers themselves.

Given the Mississippi River's value as a transportation corridor, the development and maintenance of a navigable river channel has long been a primary focus of commercial navigators and the U.S. government. The U.S. Army Corps of Engineers began its efforts on channel improvements

and snag removals in the 1800s, and in the 1930s the Corps constructed the locks and dams on the upper Mississippi River that support the current 9-foot minimum channel depth for navigation on the upper river. Further downstream, the Corps of Engineers has been involved in many other river control and channel maintenance activities, including the construction and maintenance of large Mississippi River levees and the Old River Control Structure at the divergence of the Atchafalaya and Mississippi Rivers.

In contrast to the long-standing efforts to control the Mississippi River for navigation and flood management, concerns about water quality in the Mississippi River are more recent. The Clean Water Act of 1972 and its subsequent amendments have been the driving forces of efforts over the past three decades to monitor, characterize, and take steps to improve water quality in the Mississippi River. The Clean Water Act has resulted in many improvements in Mississippi River water quality. Many point source discharges of liquid and solid pollutants to the river, such as municipal sewage systems and industrial plants, have been brought under control through regulated effluent limits, resulting in marked improvements in water quality. During the 35 years of Clean Water Act implementation, the focus of activity has been on point source discharges through the issuance and monitoring of discharge permits. Diffuse, nonpoint sources such as runoff from urban and agricultural lands have received much less attention. These sources contribute nutrients, sediments, toxic substances, and other materials to the river and have proven more challenging to control than point sources.

The 10 states along the Mississippi River corridor differ in the extent to which they have focused on monitoring and assessing water quality in the Mississippi River compared to other waterbodies within their states. For the most part, their Clean Water Act implementation efforts have focused on streams and rivers contained entirely within state borders. Large interstate rivers such as the Mississippi present special challenges for effective Clean Water Act implementation.

Long-standing and growing concerns of a number of groups about lack of coordination among states in implementing Clean Water Act provisions for protection and improvement of water quality in the Mississippi River prompted the McKnight Foundation of Minneapolis, Minnesota, to request the National Research Council (NRC) to undertake a study of the issue. The Committee on the Mississippi River and the Clean Water Act was appointed in 2005 by the NRC and conducted its deliberations and its report production in response to the Statement of Task in Box 1-1.

The committee examined how effectively the Clean Water Act has been applied in terms of protecting and restoring the water quality of the Mississippi River and how its provisions might be used even more fully. The committee did not undertake an examination of the adequacy of the

law itself. All discussions and investigations were conducted in the context of the existing Clean Water Act, with the presumption that it will not be changed substantively in the foreseeable future.

The committee held meetings in 2005 and 2006 in four cities along the Mississippi River: Minneapolis, Dubuque, St. Louis, and Baton Rouge. The committee also convened one meeting at the National Academies offices in Washington, D.C. These meetings included presentations by representatives from universities, federal and state agencies, regional stakeholder groups, and members of the public (Appendix A lists guest speakers invited to the committee's meetings). In addition to oral presentations, written comments from many state agency and interest group representatives and the public were submitted and considered. These presentations and written submittals were of significant value to the committee and made clear that the water quality of the Mississippi River and the northern Gulf of Mexico is a scientific and public policy topic of great regional and national importance.

I thank the members of the committee for their uniform commitment to the endeavor, their good cheer, and their diligent efforts. The committee brought considerable range and depth of experience and expertise to the task. Our interactions were rich and produced insights and recommendations that we hope are valuable for Mississippi River water quality planning. It was a privilege to work with this outstanding group.

I also thank the NRC staff members for their dedication and careful work over the course of the study. Jeff Jacobs, senior staff officer with the Water Science and Technology Board (WSTB), helped keep the committee on task and on schedule. Jeff and I worked collaboratively to organize and guide the committee writing assignments, to compile and edit all written contributions for a coherent consensus report, and to ensure that the views and comments of all committee members were considered in developing the report. Jeff's professional insights and his keen editing skills were most helpful and much appreciated. The committee also was ably assisted by Anita Hall, WSTB senior program associate, who handled logistics for our meetings and various aspects of report draft production and dissemination.

The committee is grateful to our sponsor, the McKnight Foundation, for financial and intellectual support of the project. We extend special thanks to Gretchen Bonfert, environment program director at the foundation, and to her colleague Ron Kroese. Gretchen and Ron were very helpful in suggesting experts and knowledgeable advocates to visit with our committee, and they carefully followed committee activities by attending public sessions of all committee meetings. The McKnight Foundation has focused on water quality in the Mississippi River and the Gulf of Mexico as a funding priority since 1992. Today, McKnight's Water Quality Collaborative, a group of many different organizations along the 10-state river corridor, is working to build coalitions to help improve Mississippi River water

quality. The McKnight Foundation is to be commended for its vision and commitment in supporting a National Academies review of this important, complex, and sometimes controversial topic.

This report was reviewed in draft form by individuals chosen for the breadth of their perspectives and technical expertise in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review was to provide candid and critical comments to assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. Reviewer comments and the draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following individuals for their review of this report: Clifton J. Aichinger, Ramsey-Washington Metro Watershed District; William L. Andreen, University of Alabama; Paul L. Freedman, Limno-Tech, Inc.; Jerome B. Gilbert, consultant; Lynn R. Goldman, Johns Hopkins University; Robert H. Meade, consultant; Patricia E. Norris, Michigan State University; Leonard A. Shabman, Resources for the Future; Richard E. Sparks, National Great Rivers Research and Education Center; Robert R. M. Verchick, Loyola University, New Orleans; and Paul D. Zugger, Public Sector Consultants.

Although the reviewers listed above provided constructive comments and suggestions, they were not asked to endorse the report's conclusions and recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Dr. Frank H. Stillinger, Princeton University, and Dr. Patrick L. Brezonik, University of Minnesota. They were responsible for ensuring that an independent examination of this report was conducted in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for this report's final contents rests entirely with the authoring committee and the institution.

The Mississippi River is a natural and economic resource of inestimable value to the nation. Its water quality affects people and ecosystems and is important to the future of the basin. There are many large-scale and complex challenges associated with Mississippi River water quality protection and restoration. Our committee has worked to consider how these challenges can be addressed within the provisions of the Clean Water Act. We hope that our efforts provide useful advice in meeting the challenges surrounding effective implementation of the Clean Water Act and in enhancing the multiple uses of the Mississippi River for future generations.

David A. Dzombak, *Chair*

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